ARTICLE IX.

Observations of the Magnetic Intensity at twenty-one Stations in Europe. By A. D. Bache, LL. D., President of the Girard College for Orphans, one of the Secretaries of the American Philosophical Society, &c., &c. Read March 6, 1840.

THE following observations of intensity and dip were made during a visit to Europe in 1836–7 and 1837–8, directed by the Trustees of the Girard College for Orphans. The special objects of my journey admitted of only an occasional attention to the observations in question, which I did not attempt unless when time and circumstances were generally favourable to their execution. The stations are twenty-one in number; three in Great Britain, and the others on the continent. At some of the places the magnetic elements are so well known from numerous observations that my results can add but little to the information already before the public; at others, few observations have been made, and my determinations assume a higher relative importance. Those of the former class will serve, by their accordance with the results of other observers, to give a general confidence in the results of the latter, and will especially assist in connecting the European stations with those in the United States, which formed one principal object of experiments, the results of which I propose to communicate to the society in a separate memoir.

At all the places but three the horizontal intensity and dip were observed, and at two the total intensities were, in addition, compared by the statical method of Professor Lloyd. The observations for the horizontal intensity were made by oscillating horizontal needles in a rarefied medium, in the manner ex-

plained in a former paper, read before the society.* The dip was determined with a six inch dipping circle by ROBINSON, which yielded quite as satisfactory results as the instrument by GAMBEY, used in my observations in the United States.† The needles for the statical method of Professor LLOYD were also by ROBINSON.‡

Two needles were ordinarily used in the observations for horizontal intensity, a cylinder of the HANSTEEN model and a bar, designated respectively as C and A in the memoir on horizontal intensity just referred to. The correction for temperature, and also, in general, the mode of observing there recorded were employed. To determine the time of beginning and ending of the oscillations, however, five sets of observations were taken,§ and the usual mode of deducing the mean, by comparing the five corresponding observations at the commencement and close of each series, was adopted. A pocket chronometer, by FRENCH, was used to observe the duration of the oscillations, and its rate during the observations was ascertained by comparison with an observatory clock, when such means was at hand. This watch had been selected in reference to its quality of bearing change of position without considerable change of rate, and stood the trial to which it was exposed reasonably well. It is my impression, however, that when more perfect instrumental means are used in the determinations, greater care will be required in regard to those for ascertaining the time. The observed correction for the rate of the chronometer is duly applied in the tables of results. As all the observations were made between the same arcs of vibration, a reduction to indefinitely small arcs is not required.‖ The correction for

* American Philosophical Society's Transactions, vol. v., N. S., Art. xviii.

† Ibid. Art. viii.

‡ They had been heated in boiling water, to discharge as much of the magnetism as could be done by this temperature, according to the recommendation of Mr. Christie. I supposed, from the result of calculations made while in Paris, that these needles lost their magnetism rapidly, but, on farther examination, find that such was not the case, and that they lost but a small portion of their force during more than a year, as will be found stated in a subsequent part of this paper.

§ Besides eliminating errors of observation, this has the farther advantage of correcting errors of division of the dial plate, as noticed by Professor FORBES, in his "Account of some Experiments made in different Parts of Europe on Terrestrial Magnetic Intensity," &c., &c. Edinburgh Transactions, vol. xiv., part I., p. 5.

‖ The semi-arcs of vibration for the cylinders were from 6° to 2°, and for the bar, from 4° to 2°.

the loss of magnetism by the needle is so fully made out, that I believe the results to be as free from error, on this score, as if no loss had appeared from observation. The time of oscillation of the bar (A) was observed at Philadelphia in October, 1835; again in September, 1836, just before I set out from home; and in December, 1838, after my return: it was observed in the intermediate time at London, in June, 1837, and again in August, 1838; at Paris in August, 1837, and in July, 1838. A curve was traced on a large scale by the results thus obtained, the ordinates representing the relative forces of the needle corresponding to the intervals of time from October, 1835, measured by the abscissæ. A regular curve being traced, departed very little from the points obtained by observation, the differences between the ordinates of the mean curve and those given by the particular observations being, in terms of the original force of the needle, 0.000, — 0.0005, + 0.0030, + 0.0034, and — 0.0031. As these individual results must be affected by small errors of observation, there can be no doubt of the satisfactory correction for loss of magnetism by using the ordinates of the curve, and, accordingly, the correction thus obtained is applied to the results, and is entered in the tables. This needle shows a tendency towards a permanent magnetic state, and its loss is less than half that of the other. The diminution of force of the cylindrical needle, (B,) since September, 1835, has been nearly uniform, and, accordingly, the curve representing it differs but little from a straight line. The observations used to trace this curve were obtained at Philadelphia in September, 1835, in September 1836, and in December, 1838; and in addition at the same times and places as stated in reference to the other needle. Although the correction for loss of force is so much greater for this needle than for the bar, there is no reason to suppose, from a comparison of their results, that this correction is not quite as well ascertained as the former. The differences between the observed losses of force and those given by the ordinates of the curve are, 0.0000, 0.0000, + 0.0035, + 0.0051, and — 0.0042. The time of oscillation of this needle was farther satisfactorily observed at Florence, before passing into lower Italy, and again in returning to upper Italy; but while the general accordance of the results was such as to show that the force had undergone no irregular change which was appreciable, the time which had elapsed between the two observations was too short to justify their use in the numerical determination of the loss of magnetism by the needle. I have had no cause to suspect irregular changes in either of the

needles since they came into my possession. The needles were always kept separate from each other; while travelling, they were carried about my person, and, when stopping for any considerable length of time, were deposited as far from iron as was necessary to their safety. From the experiments made with these needles, both of which have been magnetised several years, and which have been kept carefully for more than six years, I should be disposed, in future, to adopt the plan of procuring needles of as nearly equal force as possible,* and keeping them in pairs, which renders them much more convenient to carry. It is certain that permanence of force has not resulted, in these needles, from the opposite plan, and that the labour of observation and calculation are much increased by the necessity of ascertaining and applying a correction for the loss. In comparing two sets of experiments at a distant date, to ascertain the loss of magnetism by the needle, the results are affected by the change of dip which has taken place in the interval, and as it is not probable that this change is produced by an alteration in the total intensity, a correction is to be applied, which, however, except in the longest interval of my series, was scarcely appreciable.

The magnetic dip was observed in the usual way, the poles of the needles being reversed in each series. The bar magnets for reversing the poles were placed in the top of the box containing the dipping circle, each pair of opposite poles being connected by a keeper. Notwithstanding this arrangement, the bars lost much of their strength, probably from the percussion resulting from a slight play which was allowed in the bed where they were placed; and, on my arrival at Berlin, their magnetism was so much diminished that the dipping-needles could no longer be charged by them to saturation. Since that time I have always taken the precaution, after changing the poles, to oscillate the needles within determinate arcs, and when resting on the agate planes, to ascertain, by the time of oscillation, that they are charged at least nearly to saturation. The statement of this precaution may be of service to others, since, with a diminished force in the needles, the liability to take up some other position than that corresponding to the true dip is increased, and the error cannot, necessarily, be detected by discrepancies in the several readings. Of the two

* The importance of attending to these conditions appears very strikingly from the experiments of Mr. Airy, with large magnetic bars. Royal Society's Transactions, Part I., for 1839, pp. 196, 197.

needles accompanying the dipping circle, No. 2 did not give uniformly as accordant results as No. 1; but, in cases where differences appeared, I endeavoured, by increasing the number of observations, to reduce the amount of probable error.

In presenting these results to the society, I have concluded to give the observations at each place, in general, separately, rather than to tabulate, at once, the whole series; this will enable me more readily to make such remarks as may be necessary, and also to compare the results with those of other observers, as far as I am acquainted with them, which will make the paper more complete than if I had confined it merely to my own conclusions.*

The observations will be given in the following order:—Those at Dublin, Edinburgh, London, Paris, Brussels, Berlin, Vienna, Trieste, Venice, Rome, Naples, Florence, Milan, Turin, Chamberi, Lyons, Chamouni, the Flégierè, Genera, Brientz, and the Faulhorn.

DUBLIN.

The observations at Dublin were made in the PROVOST's garden. They included only the horizontal intensity, as I was not at this time provided with a dipping-needle. The horizontal intensity is compared with that at London by observations made in July, 1837.

Observations for Horizontal Intensity at Dublin.

Needle.	Date.					Temp.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Coeffic't of Corr'n for Loss of Magn'm.	Hor. Intensity.
	Year.	Month.	D.	H.	M.	Fah. °		Secs.	Secs.	Secs.		Lond. 1.
Cylinder.	1836	Nov.	21	4	08	$45\frac{1}{2}$	200	36.13	36.157			
"	"	"	"	"	21	$44\frac{3}{4}$	"	.14	.168			
"	"	"	"	"	39	$44\frac{1}{2}$	"	.12	.149	36.158	0.978	0.935
Bar.	1836	Nov.	19	4	40	40	200	39.77	39.862			
"	"	"	"	"	54	$39\frac{3}{4}$	150	.74	.833			
"	"	"	21	4	53	$44\frac{1}{2}$	"	.78	.851	39.849	0.992	0.938

* This is easily done through the abstract contained in Major Sabine's interesting report to the British Association, on the variation of the magnetic intensity observed at different points of the earth's surface. From the Seventh Report of the British Association for the Advancement of Science, London, 1838. I have, however, referred to the originals, whenever they were accessible, in which cases they are quoted in my paper, without other acknowledgment.

These results can add nothing to the laboured deductions of the same element by Professor LLOYD and Major SABINE, but they are important here, as indicating the accuracy with which the corrections for my needles are known, an interval of nine months having elapsed between the observations at Dublin and London. The mean of the three series with the two needles gives 0.936 for the horizontal intensity at Dublin to that at London as unity, while the mean of the determinations of the experimenters just referred to is 0.940, the two extremes being 0.946 and 0.934.*

EDINBURGH.

The following observations were made at CANAAN PARK, near Edinburgh. The instrument was much out of order, and required much time and pains to obtain the results, which, after all, are not as accordant as usual: their number probably makes up for the want of close agreement. The numbers in the column of corrected results are reduced for the rate of the chronometer,† as well as for temperature.

Observations for Horizontal Intensity at Edinburgh.

Needle.	Date.				Temp.	Number of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Coeffic't of Correction for Loss of Magnet'm.	Hor. Intensity.
	Year.	Month.	D.	H.	Fah. °		Secs.	Secs.	Secs.		Lond. 1.
Cylinder.	1837	Feb.	4	$2\frac{1}{2}$	46	250	37.05				
"	"	"	"	$2\frac{3}{4}$	"	270	.11				
"	"	"	"	3	45	250	.11				
"	"	"	"	$3\frac{1}{2}$	"	"	.08	37.107	37.107	0.986	0.895
Bar.	1837	Feb.	2	4	34	248	40.70				
"	"	"	"	$4\frac{1}{4}$	33	250	.68				
"	"	"	4	5	$44\frac{1}{2}$	330	.75	40.810	40.810	0.995	0.897

I do not find in either of Major SABINE's reports, already referred to, a comparison of the horizontal forces of magnetism at Edinburgh and London. Pro-

* See Report on the Magnetic Isoclinal and Isodynamic Lines in the British Islands. By Major Edward Sabine. From the Eighth Report of the British Association for the Advancement of Science. London, 1839. For the early receipt of a copy of this report I am indebted to the author.

† While at Edinburgh, the main spring of the chronometer gave way, and was replaced by Mr. Bryson. The watch had, subsequently, a very considerable losing rate, but I preferred to submit to this inconvenience to having frequent alterations made in it.

fessor Forbes has compared Edinburgh and Paris, and gives the intensity at the former place to that at the latter as 0.8402 to unity. My direct determination gives almost identically the same results; namely, 0.8405. Again, comparing Edinburgh and Paris through London, I find 0.841 for the horizontal intensity at the former city. Farther, using my results at Edinburgh in a comparison of Dublin and London through Edinburgh, I find 0.936 for the relative horizontal intensities at Dublin and London, agreeing within 0.004 of the mean result of Professor LLOYD and Major SABINE's observations. All these verifications go to show that my number for the relation of the horizontal intensities at Edinburgh and London is very nearly correct.

The dip was determined, at the same time and place with those of the foregoing observations, by Professor FORBES, with a small three inch circle, to be 71° 47'.5. This result differs but slightly from those of Major SABINE in September, 1836, and of Mr. Fox, in August, 1837, when reduced to this epoch, and I have employed it in determining the total intensity. Calculating this element from the mean of the horizontal intensities of the foregoing table, and using the dip observed by me at London, I find 1.013 for the total intensity at Edinburgh, that of London being unity. Major SABINE obtained, by the statical method, 1.023. I am at a loss to explain the difference between us. It does not, probably, depend upon an error in the dip used in my calculation, since, taking a mean of those which Major SABINE and Mr. FOX obtained at Edinburgh, and Major SABINE, Captain Ross, Professor PHILLIPS, Mr. FOX, and Professor LLOYD, at London, reduced to this same epoch, and using these means with my horizontal intensity, the total intensity appears to be 1.014. If my result is erroneous, the error must be in the determination of the horizontal intensity, the numerous verifications of which render it improbable that this is wrong to any considerable extent.

LONDON AND PARIS.

As these stations are of importance as references in connecting the magnetic intensity in the United States with that in Europe, I bestowed great care upon the observations, and multiplied them. They were, besides, points to which I

intended to return a second time, and which, therefore, afforded the means of ascertaining the loss of magnetism of the needles. The number of needles employed, and of observations made, may, perhaps, farther entitle these results to be allowed some weight in the determination of the relative intensity of magnetism at these two important European stations. The instrument for measuring the horizontal intensity was put in excellent order by ROBINSON, who also furnished the dipping circle and needles. Besides the horizontal needles which I ordinarily used, I employed two others, and also observed by the statical method of Professor LLOYD. The observations were made in the summer of 1837, and again in 1838, the intervals between the respective series at London and Paris being quite short. The place of observation at London was near Captain Ross' former residence, at WESTBOURNE GREEN, and at Paris, in the garden of the observatory in the MAGNETIC CABINET of M. ARAGO. The chronometer was compared, before and after the observations, with the clock of the observatory at Paris, and with the standard of Messrs. ARNOLD and DENT, at London.

Observations for Horizontal Intensity at London and Paris.

Place.	Needle.	Date.					Temp.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.	
		Year.	Month.	D.	H.	M.	Fah. °		Secs.	Secs.	Secs.		Paris 1.	Lond. 1.
London	Cylinder	1837	June	24	12	06, P. M.	71	242	35.31	35.369				
	"	"	"	"	"	30,	76¼	280	.29	.349	35.359		1.069	1.000
	Bar	"	"	"	2	49,	73½	300	38.704	38.742				
	"	"	"	"	3	10,	"	"	"	"	38.742		1.066	1.000
	H. R.	"	"	"	1	36,	77	350	31.23	31.275				
	"	"	"	"	2	01,	"	"	.29	.335	31.305		1.066	1.000
	H. B't.	"	"	16	3	42,	72½	350	25.01	25.029				
	"	"	"	"	4	01,	72	400	.01	"	25.029		1.062	1.000
Paris	Cylinder	"	Aug.	4	10	58, A. M.	69	300	34.12	"				
	"	"	"	"	11	23,	"	"	.13	"	34.286	.9958	1.000	0.936
	Bar	"	"	"	12	42, P. M.	70½	300	37.42	"				
	"	"	"	"	1	02,	70	"	.40	"	37.560	.9980	1.000	0.938
	H. R.	"	July	13	12	04,	70½	350	30.18	30.305				
	"	"	"	"	"	34,	"	"	.16	.325	30.315		1.000	0.938
	H. B't.	"	"	"	10	53, A. M.	70	400	24.19	24.286				
	"	"	"	"	11	10,	69¼	"	"	"	24.286		1.000	0.942

Observations for Horizontal Intensity at London and Paris, continued.

Place.	Needle.	Date.					Temp.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.	
		Year.	Month.	D.	H.	M.	Fah. °		Secs.	Secs.	Secs.		Paris 1.	Lond. 1.
Paris	Cylinder.	1838	July	4	1	07, P. M.	73½	350	34.956	35.076				
	"	"	"	"	1	36,	"	326	.944	.066				
	"	"	"	17	12	04,	72	350	.903	.026				
	"	"	"	"	"	35,	73	"	.850	34.971				
	"	"	"	"	1	03,	74	"	.934	35.053				
	"	"	"	"	2	06,	82½	"	.934	.038				
	"	"	"	"	"	29,	83½	"	.931	.035	35.038		1.000	0.938
	Bar.	"	"	4	3	34,	73¼	350	37.714	37.812				
	"	"	"	"	"	56,	72½	"	.703	.805				
	"	"	"	17	"	16,	84½	300	.763	.811				
	"	"	"	"	"	36,	85¼	"	.792	.836	37.816		1.000	0.936
London	Cylinder.	"	Aug.	15	1	03,	65	350	36.232	36.271				
	"	"	"	"	"	25,	"	"	.239	.278	36.274	.9962	1.066	1.000
	Bar.	"	"	"	2	23,	"	350	39.032	39.064				
	"	"	"	"	"	49,	"	"	.030	.062	39.063	.9982	1.068	1.000

The final mean of these results gives the horizontal intensity at Paris 1.066, that at London being 1.000. By a series of observations with six needles, in 1827, Major Sabine found the same element to be 1.071: the highest result which any one of his needles gave was 1.073, and the lowest 1.0675.

The following observations of the dip were made at the same places with the foregoing. At Paris, in 1837, the observations with needle No. 2 were made at such a late hour as to be unsatisfactory, from a deficiency of light; I have, therefore substituted for them the dip given by the two needles used in the statical method, and corrected by a comparison of their results at London with those of the other two needles, the poles of which were reversed. Needle No. 2 was in the hands of Mr. ROBINSON, for alteration, in 1838, and I have again used the corrected results given by the statical needles. The total intensities are calculated from the mean horizontal intensity and the observed dips.

Dip and Total Intensity at London and Paris.

Place.	Date.			Needle.	Dip.		Mean Dip.		Total Intensity.	
	Year.	Month.	D.		Degs.	Min.	Degs.	Mins.	Lond. 1.	Paris 1.
London	1837	June	16	No. 1	69	18.3				
				2		17.4	69	17.8	1.000	1.020
Paris	"	Aug.	17	Lloyd No. 1	67	16.9				
				2		21.3				
				Mean,	67	19.6				
				No. 1		23.2	67	21.4	0.980	1.000
Paris	1838	July	10	No. 1	67	16.4				
				2		16.6	67	16.5	0.980	1.000
London	"	Aug.	15	Lloyd No. 1	69	12.9				
				No. 2		12.3				
				Mean,	69	12.6				
				No. 1		12.1	69	12.3	1.000	1.020

The report of Major SABINE on the magnetic survey of the British Islands affords ample authentic materials for putting these results to the test. Professor PHILLIPS, who observed the dip, in May, 1837, at the same place where my observations were made, found it 69° 20′.2; and again, in March, 1838, 69° 18′.2, which, reduced to the epoch of my observations, at the rate of a diminution of 0′.2 per month, would give (the correction being additive) 69° 20′.4. The dip observed by Major SABINE in Regent's Park, in July, 1837, reduced to the same epoch, is 69° 18′.9, and by an observation in November, 1837, 69° 25′.0. That found by Capt. JAMES Ross, at Westbourne Green, in August, 1837, similarly reduced, gives 69° 20′.8; in June and July, 1838, 69° 17′.0; and in December, 1838, 69° 17′.4. That of Professor LLOYD, in 1836, also, reduced, is 69° 20′.8; and of Mr. FOX, in May and June, 1838, 69° 20′.5. The mean of all these determinations, omitting the dip of 69° 25′.0, is 69° 19′.5. I am not acquainted with any series of determinations, at the same place, by different observers, and with different instruments, which agree so closely, and consider it, therefore, as an important point in verifying my results, that the dip observed in 1837 agrees within 1′.7 of the mean of those just referred to. The second determination of 69° 12′.3, in 1838, is in defect 4′.8, supposing the annual decrease of dip to be 2′.4, a difference which is admissible, since nearly

as great a one is to be found among the foregoing results. The determinations of the dip at Paris agree very well with that given by Professor FORBES, on the authority of M. ARAGO, in July, 1835,* namely, 67° 24′.0. An annual diminution of dip of 2′.8 would give, in August, 1837, 67° 18′.2, while I found 67° 21′.4; and in July, 1838, 67° 15′.6, while my result was 67° 16′.5.

It is obvious, then, that my value of the total intensity is correct or not, according as the horizontal intensity has or has not been accurately determined. I shall return to this, after stating the results obtained by the statical method of Professor LLOYD. As the observations in 1837, by this method, were made at the short interval of a month from each other, I have not thought it necessary to apply a correction to them, the whole loss of magnetism, during the year, by either needle, having amounted to less than 0.01.

Observations for Total Intensity at London and Paris, by the Statical Method.

Place.	Date.		Needle.	Temp.	Dip when loaded, or Angle θ.		Dip reduced to August, or Angle δ.		Total Intensity, or Cor. θ / Sui $(\delta - \theta)$
	Month.	Year.		Fah. °					
London	June	1837.	No. 1,	74½	21°	59′.0	69°	17′.5	
Paris	Aug.	"	"	72⅓	24	47 .3	67	21 .0	0.979
London	June	"	No. 2,	74½	19	13 .5			
Paris	Aug.	"	"	72½	22	48 .2			0.976
London	Aug.	1838.	No. 1,	65	22	31 .3	69	12 .3	
Paris	July	"	"	75	25	41 .7	67	16 .2	0.979†
London	Aug.	"	No. 2,	65	19	59 .4			
Paris	July	"	"	77	23	12 .5			0.980†

The horizontal intensity deduced from these results by using the dip already given, is 1.065, agreeing closely with the determination by the method of vibrations. This latter determination rests upon 4072 oscillations at one station, and 6426 at the other, besides the verification by the statical method. The foregoing results are collected in the following table.

* See the paper of Professor Forbes before referred to, in the Edinburgh Transactions, vol. xiv. p. 27.

† A small correction has been applied for the effect of temperature, amounting to 0.003 and 0.002 in the two cases respectively.

Horizontal and Total Intensities and Dip at London and Paris.

Date.	Needle.	Horizontal Intensity.		Total Intensity.		Magnetic Dip.	
		Paris.	London.	Paris.	London.	Paris.	London.
1837. June, July, Aug.	Cylinder.	1.069	1.000	0.982	1.000	67° 21′.4*	69° 17′.8†
	Bar.	1.066		0.980			
	H. R.	1.066		0.980			
	H. B.	1.062		0.976			
	Lloyd No. 1.	1.067		0.980			
	" " 2.	1.063		0.976			
1838. July, Aug.	Cylinder.	1.066		0.980		67° 16′.5	69° 12′.3
	Bar.	1.068		0.981			
	Lloyd No. 1.	1.067		0.981			
	" " 2,	1.066		0.980			
	Mean,	1.066	1.000	0.979	1.000		
		1.000	0.938	1.000	1.021		

BRUSSELS.

The horizontal intensity at Brussels compared with that at Paris being well known through the observations of M. QUETELET and others, it is important to me as a verification of my results, and as connecting stations in the United States with those in Europe, to compare my determinations with those already on record. The dip at Brussels is also, no doubt, accurately known from the regular observations of M. QUETELET since 1827; and I regretted that an accident which had happened to my dipping circle at Paris prevented me from farther putting its accuracy to the test. The observations for horizontal intensity were made in the garden of the OBSERVATORY. The chronometer was compared with the observatory clock before and after the observations.

* The mean of this result and that obtained in 1838, reduced to August 16th, 1837, allowing a diminution of dip yearly of 2′.8, is 67° 20′.8.

† The mean of this result and that in 1838, reduced to June 16th, allowing an annual decrease of dip of 2′.4, (see Major Sabine's Report on the Magnetic Survey of the British Islands,) is 69° 16′.0.

Observations for Horizontal Intensity at Brussels.

Needle.	Date.				Temp.	Number of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Correction for Loss of Magnetism.	Hor. Intensity.
	Year.	Month.	D.	H.	Fah. °		Secs.	Secs.	Secs.		Paris 1.
Cylinder.	1838	July	25	$2\frac{1}{4}$, P. M.	62	300	35.596	35.640			
"	"	"	"	$2\frac{1}{2}$, "	61	300	.599	.644	35.642	1.0026	0.968
Bar.	"	"	"	$3\frac{1}{2}$, "	60	350	38.366	38.417			
"	"	"	"	$5\frac{1}{2}$, "	57	350	.334	.398	38.407	1.0002	0.970

The mean of these results, 0.969*, is in close accordance with the results before referred to as given by M. QUETELET, the mean of the several series of observations made at Brussels between 1828 and 1838 being nearly 0.964.

BERLIN.

I am indebted for an opportunity to make this set of observations to the kindness of Professor ENCKE, who put his convenient MAGNETIC OBSERVATORY at my disposal, and removed from it the variation magnetometer and dipping needle which it contained: without this, I could not have observed at this season of the year. In my first attempts to obtain the dip I was unsuccessful, owing to the great loss of force which my magnets for reversing the poles of the dipping needle had sustained during a circuitous journey from Switzerland to this capital. The magnets were retrenched by ŒRTEL, and the results then obtained appear worthy of confidence. Since this time I have taken the precaution to oscillate the dipping needles before observing with them after the reversion of the poles, to ascertain that they are charged nearly, or quite, to saturation. As the periods which elapsed between these observations and those which preceded and succeeded them, at Paris, were not very different, I have calculated the intensity at Berlin in reference to both the series at Paris, applying the correction for the loss of magnetism by the needles, deduced as

* This number differs by 0.001 from the result given by M. Quetelet in the Bulletin of the Brussels Academy, vol. v. p. 481. In the numbers communicated to him I had applied a correction for the loss of magnetism of the needles which was too high by nearly this difference; which is, however, entirely unimportant.

already stated. The coincidence of the two results shows strikingly the accuracy with which the curve already described supplies the data for the correction of the loss of force by the horizontal needles.

The chronometer was compared with the observatory clock.

Observations at Berlin.

For Horizontal Intensity.											
Needle.	Date.				Temp.	No. of Series.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Correction for Loss of Magnet'm.	Horizontal Intensity.
	Year.	Month.	D.	H.	Fah. °			Secs.	Secs.		Paris 1.
Cylinder	1837	Dec.	16	2, P. M.	37½	2	690	34.966	35.006	1837. 1.015 — 1838. 0.975	0.974 0.977
Bar	1837	"	"	2¼ "	35	2	660	37.886	37.993	1837. 1.005 — 1838. 0.993	0.983 0.984
										Mean, . .	0.979

For Dip.
1837, Dec. 29, Needle No. 1, 68° 06′.5
No. 2, 68 10 .6 Mean, 68° 08′.5.
Total Intensity compared with Paris as unity, 1.0145.

The horizontal intensities of Berlin and Paris were compared by M. Rudberg, who made the relation 0.974, and by M. Quetelet,* who gave 0.975 for the relative intensities. My result differs but slightly from these.

The dip at Berlin is very well known from a series of observations extending from 1806 to 1837, and my result can add nothing to the knowledge of this element, but as obtained with the same instrument which was used at Paris, the total intensity will be, probably, a nearer approximation by using it than

* Annuaire de l'Observatoire de Bruxelles pour l'an 1834, p. 266. On the next page M. Quetelet gives 0.9886 for the relative intensities, but this is doubtless a mistake.

by employing in the calculation the more accurate determination of the long series just referred to.

Professor ENCKE has determined from this series a formula by which the dip may be calculated for any epoch, namely, $\delta = 68° 7'.3 - 3'.52\ (t - 1836,)$ in which δ is the dip and t the year or fraction of a year. The dip in December, 1837, calculated from this formula, is 68° 00'.4, from which my result differs about eight minutes.

MM. HUMBOLDT and GAY LUSSAC determined, in 1809, the relative intensities at Berlin and Paris to be 1.014; M. ERMAN, in 1828, and M. QUETELET in 1829, 1.0165.* My determination is 1.0145.

VIENNA.

These observations were made in the BOTANIC GARDEN, upon the upper platform. The chronometer was compared, before and after the observations, with the observatory clock. The time of ten oscillations and the dip are compared with the mean of the observations at Paris in 1837 and 1838, in calculating the horizontal and total intensities.

Observations at Vienna.

FOR HORIZONTAL INTENSITY.

Needle.	Date.				Temp.	No. of Series.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
	Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.000.
Cylinder.	1838	March	23	$3\frac{3}{4}$, P. M.	58.3	2	700	33.436	1.0076	1.084
Bar.	"	"	"	$4\frac{1}{2}$, "	57.8	2	700	36.043	1.0023	1.096
									Mean,	1.090

FOR DIP.

1838, March 21, Needle No. 1, 64° 45'.8.
No. 2, 53 .7. Mean, 64° 49'.7.

Total Intensity compared with Paris as unity, 0.989.

The only published observations of magnetic intensity at Vienna with which I am acquainted are those quoted by Major SABINE, in his recent report, as

* Major Sabine's Report on the Magnetic Intensity of the Earth.

made by KEILHAU and BOECK, and which give the total intensity at Vienna, as compared with Paris, 0.983, differing from the above only 0.006.

The numbers for the horizontal intensity furnished by the two needles sometimes, as in this particular case, differ; and, in general, the greater relative intensity is given by the bar needle. After an examination of various causes which suggested themselves as likely to produce this result, I am still at a loss to explain it. It is not due to an ill-ascertained correction for the loss of magnetic force, nor for temperature, nor to a want of horizontality in the magnetic axis of the needle. The mode of observing renders the limits of error in the separate sets of observations much below these differences. It was my practice in observing to employ the cylinder needle which has a very small correction for temperature first, and, mean while, to place the other in the shade, so as to avoid an error from its not having acquired the temperature of the surrounding air.

TRIESTE AND VENICE.

The observations at Trieste were made in the BOTANICAL GARDEN, and those at Venice in the garden of the ARMENIAN CONVENT, on the Island of St. Lazarus.

Observations at Trieste and Venice.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscill'ns.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Trieste	Cylinder	1838	April	4	$10\frac{3}{4}$, A. M.	54.0	2	700	32.889	1.0091	1.121
	Bar	"	"	"	$11\frac{3}{4}$, "	54.5	2	580	35.426	1.0024	1.135
										Mean,	1.128
Venice	Cylinder	1838	April	11	$12\frac{1}{4}$, P. M.	67.5	2	700	32.876	1.0097	1.122
	Bar	"	"	"	$1\frac{1}{2}$, "	67.6	2	700	35.393	1.0029	1.137
										Mean,	1.129

FOR DIP.

Trieste, 1838, April 4th, Needle No. 1, 63° 19′.1
No. 2, " 22 .5 Mean, 63° 20′.5

Venice, 1838, April 11th, Needle No. 1, 63° 18′.9
No. 2, " 24 .9 Mean, 63° 21′.9

Total Intensity at Trieste, compared with Paris as unity, 0.970.
" " Venice, " " " " 0.9715.

In this table the mean time of the oscillations at Paris and the mean of the observed dips in 1837 and 1838, is taken as the unit of reference in calculating the relative horizontal and total intensities.

The total intensity at Trieste, compared with Paris, is given by Major SABINE, in his report before referred to, as determined by Messrs. KEILHAU and BOECK, in 1826, as 0.977; differing from the mean of my results 0.007, the difference between us having a contrary sign from that at Vienna. M. QUETELET* gives the horizontal intensity at Venice as 1.1566, which is much greater than my number.

ROME AND NAPLES.

The observations at Rome were made at two different stations; one out of the region of the volcanic tufa upon which the city is built, upon the calcareous formation of MONTE MARIO, in the garden of the Villa Mellini, the other in the temple of Venus and Rome, opposite to the Colosseum. At the latter station a curious instance of local attraction occurred: I had selected a block of marble, apparently free from iron fastenings of any sort, as the resting place for the instrument, and finding results very discordant from those obtained on the Monte Mario, I next placed the instrument in a brick niche, to examine if the local attraction were common to the whole station. The results obtained when the instrument was in the niche were so different from the former that I placed it again upon the block, to ascertain if any mistake had occurred, but found again the same anomaly as at first. There was, probably, some iron beneath the pavement upon which the block of marble rested, suggesting the necessity for caution in the selection of these places of observation.

Fearing the influence of the ferruginous nature of the volcanic tufa upon which Naples is built,† I went to AVERSA, about eight miles to the north of the city. The place of observation was in the large garden attached to the Asylum for the Insane.

* Annuaire de l'Observatoire de Bruxelles pour l'an 1834.

† I certainly did not at that time remember that M. QUETELET had expressed his opinion that there was no local disturbance from this cause, or I should have deferred to his authority. Nevertheless, the precaution, though attended with some inconvenience, was not amiss.

At Rome the chronometer was compared, before and after the observations, with the observatory clock of the Roman College, and, at Naples, with that of the Royal Observatory.

The horizontal intensity observed at Paris, for 1838, is taken as unity in the calculations, the correction for loss of force in the needles being applied for the same epoch. The dip which is used in calculating the total intensity is a mean of that actually observed at Paris in 1838, and of that which would result from applying the yearly diminution of 2′.8 to the dip observed in 1837.

Observations at Rome and Naples.

For Horizontal Intensity.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscill'ns.	Time of Ten Oscill'ns. at 60°.	Coeffic't of Correction for Loss of Magnet'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Rome*	Cylinder	1838	May	18	$8\frac{1}{2}$, A. M.	67.3	2	650	31.574	0.9935	1.223
	Bar	"	"	"	$9\frac{1}{2}$, "	67.0	2	600	34.122	0.9981	1.226
Rome†	Cylinder§	"	"	"	P. M.	65.0	1	350	31.539	0.9935	1.226
		"	"	"	"	66.2	1	350	31.777		Rejected.
										Mean,	1.225
Naples‡	Cylinder	1838	May	7	8, A. M.	76.2	2	700	31.290	0.9921	1.244
	Bar	"	"	"	$11\frac{3}{4}$ "	75.2	1	350	33.674	0.9977	1.258
										Mean,	1.249

For Dip.

Rome,‖ 1838, May 15, Needle No. 1, 60° 13′.1
18, " No. 2, " 14 .9 Mean, 60° 14′.0.

Naples,¶ 1838, May 7, Needle No. 1, 59° 04′.8
" " No. 2, " 05 .5 Mean, 59° 05′.1.

Total Intensity at Rome, compared with Paris as unity, 0.9525.
" " Naples, " " " " 0.9380.

In taking the means for the horizontal intensity, weight is allowed in proportion to the number of oscillations observed.

The observations at Rome confirm the statement of M. QUETELET, that no effect is produced upon the needle by the volcanic tufa.

* Monte Mario. † Temple of Venus and Rome. ‡ Aversa.
§ In niche, on stone. ‖ Monte Mario. ¶ Aversa.

The numbers assigned for the horizontal intensities at Rome and Naples, by M. QUETELET, are, respectively, 1.2471 and 1.2869, differing very considerably from my results. My total intensities agree, however, very nearly with those found by HUMBOLDT and GAY LUSSAC, which were, for Rome, 0.945, and for Naples, 0.938.

FLORENCE AND MILAN.

The observations at Florence were made in the BOBOLI GARDENS; those at Milan in the garden of M. KRAMER, near the PORTA NUOVA. The chronometer was compared, at both places, with the observatory clock.

The same data at Paris, which were referred to under the the head of Rome and Naples, were used in the calculations in the following table.

Observations at Florence and Milan.

FOR HORIZONTAL INTENSITY.											
Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Florence	Cylinder	1838	May	28	$2\frac{3}{4}$, P. M.	68.2	2	700	32.395	.9947	1.164
	Bar	"	"	"	$3\frac{3}{4}$, "	67.0	2	"	34.838	.9985	1.176
										Mean,	1.170
Milan	Cylinder	1838	June	10	1, P. M.	73.7	2	600	33.269	.9964	1.106
	Bar	"	"	"	2, "	72.1	2	"	35.765	.9989	1.117
										Mean,	1.112
FOR DIP.											
Florence, 1838, May 28th, Needle No. 1, 62° 06′.5 No. 2, " 04 .5 Mean, 62° 05′.5											
Milan, 1838, June 10th, Needle No. 1, 63° 54′.1 No. 2, " 55 .4 Mean, 63° 54′.7											
Total Intensity at Florence, compared with Paris as unity, 0.965. " " Milan, " " " " 0.972.											

The same numbers for Paris being employed as in the preceding calculations, and referring to 1838, I thought it might be satisfactory to ascertain if any part of the differences of horizontal intensity, as shown by the two needles, (amounting, in the results at Florence and Milan, to .012 and .011,) could be explained by an erroneous correction for loss of magnetism. Referring the horizontal intensities to 1837, however, when the correction has the contrary effect from that in the table, the same difference results.

Nor does this depend upon some peculiarity in the observations at Paris, since, referring to the observations at London, and taking the horizontal intensity there as unity, nearly the same difference appears.

The horizontal intensities determined by M. QUETELET at these two stations both exceed my results, his number for Florence being 1.1830, and for Milan 1.1335. The total intensities obtained by MM. HUMBOLDT and GAY LUSSAC were, for Florence, 0.9481, and for Milan 0.9733, both of which numbers are less than mine.*

TURIN AND CHAMBERI.

The place of observation at Turin was in the BOTANIC GARDEN; at Chamberi, in the PARK of the COUNT DE BOIGNES, a short distance only from the town. At Turin the chronometer was compared with the observatory clock, and the same rate was applied at Chamberi. The comparison is made with the observations at Paris in 1838.

Observations at Turin and Chamberi.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns. at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Turin	Cylinder Bar	1838	June	17	11, A. M.	82.5	2	600	33.440	.9987	1.096
		"	"	"	12, M.	83.0	2	"	36.149	.9992	1.093
										Mean,	1.0945
Chamberi	Cylinder Bar	1838	June	21	12¾ P. M.	78.2	2	700	33.539	.9989	1.090
		"	"	"	2 "	77.5	2	"	36.235	.9993	1.088
										Mean,	1.089

FOR DIP.

Turin, 1838, June 17, Needle No. 1, 63° 48′.8
18, " No. 2, " 55 .6 Mean, 63° 52′.2.

Chamberi, 1838, June 21, Needle No. 1, 64° 31′.5
No. 2, " 37 .5 Mean, 64° 35′.0.

Total Intensity at Turin, compared with Paris as unity, 0.959.
" " Chamberi, " " " " 0.979.

* The authorities for these numbers are the same as previously quoted. In the remainder of the paper, unless the contrary is stated, the numbers are derived from the same sources, namely, the Annual of the Brussels Observatory for 1834, or the Transactions of the Brussels Academy of Sciences, vol. vi., and the Report of Major Sabine on the Magnetic Intensity.

M. QUETELET assigns 1.112 as the horizontal intensity at Turin, and MM. HUMBOLDT and GAY LUSSAC give 0.9911 as the total intensity. The latter number exceeds my determination very considerably.

LYONS.

These observations were made in a meadow to the south-east of Lyons, and across the Rhone from the city. In reducing the time of ten oscillations for the rate of the chronometer, the mean of the rates at Turin and Paris, which differed very slightly, has been employed.

Observations at Lyons.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Lyons	Cylinder Bar	1838	June	25	$12\frac{1}{4}$, P. M.	75.7	2	700	33.739	.9991	1.077
		"	"	"	$2\frac{1}{2}$, "	74.1	2	750	36.391	.9995	1.079
										Mean,	1.078

FOR DIP.

Lyons, 1838, June 24, Needle No. 1, 64° 49′.5.
No. 2, 48 .6. Mean, 64° 49′.0.

Total Intensity at Lyons, compared with Paris as unity, 0.978.

According to MM. HUMBOLDT and GAY LUSSAC, the total intensity at Lyons is .9889.

CHAMOUNI AND THE FLÉGIÈRE.

The place of observation which appeared to me most suitable, at the time of my visit to Chamouni, was in a field in rear of, and at some distance from, the Union Hotel. On the Flégière the observations were made not far from, and about thirty feet above, the point where the cross is placed. The height of this point above the Valley of Chamouni is, in round numbers, about 3500 feet, and the valley itself is 3400 feet above the level of the sea.

These observations having been made in August, 1837, are compared with those at Paris in 1837, the dip being obtained, however, as in the similar case of 1838, by using both series of observations. The rate of the chronometer determined at Geneva was used in the reduction.

Observations at Chamouni and the Flégière.

For Horizontal Intensity.											
Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Chamouni	Cylinder Bar	1837	Aug.	26	9½, P. M.	53.0	1	150	32.902	1.002	1.088
		"	"	"	10, "	50.0	2	300	36.006	1.001	1.089
										Mean,	1.0885
The Flégière	Cylinder Bar	1837	Aug.	26	12, M.	68.0	2	650	32.768	1.002	1.097
		"	"	"	12¾, P. M.	69.5	1	300	35.945	1.001	1.101
										Mean,	1.099
For Dip.											
Chamouni, 1837, Aug. 26, Needle No. 1, 64° 38′.7 No. 2, 64 37 .7 Mean, 64° 38′.2.											
The Flégière, 1837, Aug. 26, Needle No. 1, 64° 35′.8.											
Total Intensity at Chamouni, compared with Paris as unity, 0.979 " " on the Flégière, " " " " 0.987											

The horizontal intensity in the Valley of Chamouni, according to Professor Forbes, is 1.076,* and to M. Quetelet, 1.0935.† My result agrees nearly with the latter. The higher station presents a greater horizontal and total intensity than the lower, contrary to the general deduction from the laboured and ingenious memoir of Professor Forbes on this subject. It is worthy of remark, however, that the number given by Professor Forbes for the horizontal intensity at the Jardin is greater than that for the valley. M. Quetelet, on the contrary, found a less horizontal intensity on the Mer de Glace than at Chamouni. The anomaly is probably real, and adds another to the instances presented by Professor Forbes, of the difficulties of the problem of which he has

* Edinburgh Transactions, vol. xiv., part I.

† Annuaire de l'Observatoire de Bruxelles pour l'an 1834.

successfully undertaken the solution. The dip given by Professor FORBES, at Chamouni, is 65° 00′, and at the Jardin, 64° 58′, both differing considerably from my results.

GENEVA.

These observations were made in the garden of M. PREVOST-MARTIN, not far from the city; those with the cylindrical needle on the 24th of August and 1st of September, those with the bar on the first occasion; the dip was measured on the second. The observations at Chamouni intervened between the two sets at Geneva. The loss of the chronometer was ascertained from the standard near the Church of St. Peter, which is rated for the use of the watch-makers.

The numbers for Paris used in the reductions were obtained as stated under the head of Chamouni.

Observations at Geneva.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Geneva	Cylinder	1837	Aug.	24	1, P. M.	81.2	2	662	32.904	1.0023	1.088
	"	"	Sept.	1	1½, "	68.5	1	300	33.033	1.0032	1.081
	Bar	"	Aug.	24	1¾, "	82.0	2	650	36.048	1.0008	1.086
										Mean,	1.086

FOR DIP.

Geneva, 1837, Sept. 1, Needle No. 1, 64° 52′.4.
No. 2, 47 .3. Mean, 64° 49′.8.

Total Intensity at Geneva, compared with Paris as unity, 0.984.

The horizontal intensity at Geneva, compared with that at Paris, is stated by M. QUETELET* to be 1.0805, and by Professor FORBES†, 1.071; my own result agrees best with the former. Professor FORBES determined the dip, in August, 1832, to be 65° 05′, and states that it was found, in 1825, by M. ARAGO,

* Annuaire de l'Observatoire de Bruxelles, &c., 1834.

† Edinburgh Transactions, vol. xiv.

to be 65° 48′.5. Adopting 2′.8 as the annual decrease of the dip at Geneva, the observations of Professor FORBES would give, for the epoch 1837, 64° 51′.0, and those of M. ARAGO, 65° 14′.9.

BRIENTZ AND THE FAULHORN.

These observations were made at places only about fourteen miles apart, but differing in elevation 6800 feet: the lower station itself (Brientz) is about 8900 feet above the level of the sea. The Faulhorn was one of the stations of Professor FORBES in his Alpine observations; and Brientz is about twelve miles W. N. W. of another of his stations, Meyringen.

The observations at Brientz were made in a field in rear of, and about a hundred yards from the White Cross Hotel; those at the Faulhorn nearly on the very summit, and as far from the chalet as the ground would permit.

The chronometer was rated at Zurich, and the rate, which differed but little from that found at Geneva, has been applied in the following table. The numbers already referred to for Paris, in 1837, have been used in the calculations.

Observations at Brientz and the Faulhorn.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns. at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Brientz	Cylinder Bar	1837	Sept.	22	11, A. M.	65.0	2	700	33.162	1.0056	1.075
		"	"	"	12½, P. M.	64.8	2	600	36.141	1.0020	1.082
										Mean,	1.078
The Faulhorn	Cylinder Bar	1837	Sept.	20	3 P. M.	50.5	2	700	33.078	1.0054	1.080
		"	"	"	4 "	43.7	2	600	36.082	1.0017	1.085
										Mean,	1.082

FOR DIP.

Brientz, 1837, Sept. 22, Needle No. 1, 64° 59′.5
No. 2, 65 15 .0 Mean, 65° 06′.7.

The Faulhorn, 1837, Sept. 20, Needle No. 1, 65° 01′.5
No. 2, " 01 .9 Mean, 65° 01′.7.

Total Intensity at Brientz, compared with Paris as unity, 0.9869.
" " Summit of the Faulhorn, " " 0.9874.

The difference in the dip at Brientz, as shown by the two needles, (No. 1 and No. 2,) is very considerable, and, from the separate observed quantities, the results by No. 2 would appear more worthy of confidence than that by No. 1.

The two horizontal needles, oscillated by Professor FORBES, on the Faulhorn, gave 1.071 and 1.060, mean 1.065 for the horizontal intensity compared with Paris, and the needle oscillated at the lower station, Meyringen, for comparison, 1.075. My results, both at the upper and lower stations, exceed these, being 1.082 and 1.078. The difference of the horizontal intensities at the upper and lower stations appears equally from my series and that of Professor FORBES to have been very small; less, in fact, than the differences between two needles at the same station.

I am not aware that Professor FORBES determined the dip at his two corresponding stations. Using the mean dip for Brientz, the total intensity at the lower station appears very nearly the same with that at the upper; using the dip given by needle No. 1, it would, of course, be less; and using that shown by needle No. 2, it would exceed the total intensity at the upper station by only .0046.

The details given in the preceding pages appear to me essential, in order to a just conclusion as to the character of the results, and for reference in regard to the localities and circumstances of the observations. The comparisons of my conclusions with those of others, as far as I am acquainted with them, will probably be found convenient, and, in some cases, had a specific object in reference to these observations themselves. The results being thus unavoidably scattered, I have thought it best, in conclusion, to present them in a single table, divested of particulars.

The results are arranged in the order of the total intensities and columns are inserted for the latitude and longitude of the places.

No.	Place.	Latitude.		Longitude from Paris.		Date.	Horizontal Intensity.	Dip.		Total Intensity.
		°	′	°	′		Paris = 1.	°	′	Paris = 1.
1	Edinburgh.	55	57 N.	5	32W.	Feb. 3, 1837.	0.841	*	*	
2	Dublin.	53	23 "	8	41 "	Nov. 20, 1836.	0.879	*	*	
3	London.	51	31 "	2	26 "	June 16, 1837.	0.939†	69	16.0	1.021
4	Brussels.	50	51 "	2	02 E	July 25, 1838.	0.969	*	*	
5	Berlin.	52	32 "	11	02 "	Dec. 16, 1837.	0.979	68	08.5	1.014
6	Paris.	48	50 "	0	00 "	Aug. 17, 1837.	1.000	67	20.8	1.000
7	Vienna.	48	13 "	14	02 E.	March 23, 1838.	1.090	64	49.7	0.989
8	The Flégierè.					Aug. 26, 1837.	1.099	64	35.8	0.987
9	Brientz.					Sept. 22, "	1.078	65	06.7	0.987
10	The Faulhorn.					Sept. 20, "	1.082	65	01.7	0.987
11	Geneva.	46	12 "	3	49 "	Aug. 25, "	1.086	64	49.8	0.984
12	Chamberi.					June 21, 1838.	1.089	64	35.0	0.979
13	Chamouni.					Aug. 26, 1837.	1.088	64	38.2	0.979
14	Lyons.	45	46 "	2	29 "	June 25, 1838.	1.078	64	49.0	0.978
15	Milan.	45	28 "	6	51 "	June 10, "	1.111	63	54.7	0.972
16	Venice.	45	26 "	10	01 "	April 11, "	1.129	63	21.9	0.971
17	Trieste.	45	38 "	11	27 "	April 4, "	1.128	63	20.5	0.970
18	Florence.	43	47 "	8	55 "	May 28, "	1.170	62	05.5	0.965
19	Turin.	45	04 "	5	20 "	June 17, "	1.094	63	52.2	0.959
20	Rome.	41		10	10 "	May 18, "	1.225	60	14.0	0.952
21	Naples.	40	52 "	11	57 "	May 7, "	1.249	59	05.1	0.938

* Dip not observed. † Mean of results in June, July, and August, 1837, and in July and August, 1838.

ERRATUM.

Page 96, (in table,) column headed "No. of Oscillations," first line, for 150, read 350.